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AGRICULTURAL MACHINERY NOISE

INTERNATIONAL HARVESTER COMPANY

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AGRICULTURAL MACHINERY NOISE

INTERNATIONAL HARVESTER COMPANY

Presentation to

ENVIRONMENTAL PROTECTION AGENCY

Office of Noise Abatement and Control

Denver, Colorado

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presented by:

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The International Harvester Company is a multi-divisional organization wherein each division operates relatively autonomously to design, develop, manufacture, market, and support its particular product lines. Our Farm Equipment Division is responsible not only for farm equipment, but also for lawn and garden equipment. It also produces the light industrial products which were included in our earlier presentation at Atlanta, Georgia.

As with our other products, we have in recent times been evaluating our lawn and garden and farm equipment sound levels in terms of measurements 50 feet from the machine. The machines are operated at the maximum loading for the particular vocational application being considered. This environmental sound level (or ESL) is measured with the "A" weighting network, in decibels, and is designated dBA.

Our presentation is organized on an ascending scale, starting with the small walk-behind lawnmowers and progressing up through the large diesel tractors and combine-type harvesting machines.

Lawn and garden equipment is characterized by single cylinder air cooled engines, and relatively few hours of weekly operation. Our smallest equipment is walk-behind lawnmowers (Figure 1). Typical ESL measured at 50 ft. during mowing operations is 66 dBA.

The next class of equipment is the riding lawnmower (Figure 2). ESL during mowing runs about 70 dBA, but it's interesting to note that the 50 ft. ESL on a paved area with the mower blade running full speed is about 76 dBA. The grass helps quiet things down significantly.

Our lawn and garden tractors make up the balance of lawn and garden equipment (Figure 3). Most of these tractors are sold with a rotary mower, and ESL mowing grass runs 76 dBA - 78 dBA.

It is interesting to note that much of the noise of mowing with a rotary mower, whether a large highway mower or a small lawn mower, is

the mower itself, not the engine powering it. It is, after all, just a sort of a fan, and the blade tip speed is in the neighborhood of 200 miles per hour. It makes a noise when you push something through the air that fast. If the blade is going much too slow, of course, the mower won't cut. If it's going a little too slow the mower will plug with grass clippings or leave them in a windrow instead of uniformly scattering them.

Farm equipment is typically powered by four, six, or sometimes eight cylinder engines, usually water cooled. It may be self-propelled, i.e., have its own engine and drive mechanism, or it may be attached to a tractor which also powers it.

Typical of self-propelled equipment is the combine (Figure 4), which gathers and cleans grain, and loads it into a truck or wagon. With all its harvesting mechanism operating, a typical combine standing in an unpaved lot has an ESL of 88 dBA.

Other self-propelled machines include sprayers, windrowers, and cotton pickers. I wouldn't expect any of these to have higher sound level than the combine.

Other farm equipment includes tractors and implements. These tractors cover a power range from 30 hp to 140 hp, and have maximum ESL values from about 80 dBA to 90 dBA, with most between 83 dBA and 88 dBA. Tractors do not always operate at full load, of course, so when loads are less than maximum, the sound levels are usually lower.

As a matter of information, we find that gasoline powered tractors usually run 3 to 4 dBA quieter than diesel tractors when at full power. Diesel power, on the other hand, results in lower operating costs so the challenge is in balancing economics with desired goals.

Many implements such as planters and cultivators do not load the tractor to full power. Consequently the noise level is much reduced. For example, a typical cultivator-tractor combination (Figure 5) measured 81-82 dBA at full working speed. The same tractor under full load with a plow measured 86 dBA. In another case, a tractor pulling a planter (Figure 6) was found to have a maximum ESL of 75 dBA. The same tractor under full load tillage operation would be about 84 dBA.

Mechanical limitations presently determine the size of mowing equipment, (Figure 7), and ESL of these machines in combination with tractors ranges from 71 to 79 dBA. I would expect these mechanical limitations to the size of mowing machines to continue to keep them among the less noisy agricultural machines.

Many tillage tools such as plows (Figure 8) and disc harrows require full tractor power, and although they make negligible noise themselves, when they are being used the ESL will be at the maximum for the tractor, usually 83 dBA to 88 dBA.

Equipment used around the farmstead presents a measurement problem, because of the proximity of buildings. While the readings we get are real, they are as much a function of the site as of the machinery running. At our experimental facility near Hinsdale, Illinois, we measured a silo-filling operation using a blower and a self-unloading wagon, each powered by its own tractor (Figure 9). The silo is next to a large metal building, fairly typical of farm layouts. We were able to measure the ESL to the front and rear of the tractor, and on the side away from the building. Our readings varied from 76 dBA to 85 dBA depending upon location. I'm sure we would have different results if we could generate and measure the same sound in the middle of an open area, but that's not where this equipment is used.

Forage harvesters (Figure 10) are high-power-requirement machines, causing full tractor noise and are a noise source themselves as well. The ESL for these machines in combination with the tractor powering them runs around 86 dBA to 88 dBA. These values were measured on the side of the tractor away from the forage harvester, and the readings might be higher on the other side, but that's where the crop is still standing, and there shouldn't be any human exposure. Also, I would expect the crop to muffle the sound.

As a matter of fact, there is little exposure to most agricultural machinery on the part of anyone except the operator. There are several reasons for this. First is the fact that most agricultural operations occur in relatively uninhabited areas, and they seldom attract casual observers. Secondly, these operations are seasonal and mobile. Even if one lives next to a cultivated field, it only gets plowed probably one day a year, and even then only one pass is next to the house, all the others are farther away and therefore quieter. It probably gets disced once, and then all other operations such as planting and cultivating are relatively quiet until harvest day, with again only one pass through the field next to the house.

Operations which take place in more inhabited areas are also intermittent, and generally lower in ESL than many other things in the same area. A tractor with a rotary cutter of the type used for highway roadside maintenance, (Figure 11) was measured at 76 dBA. The trucks using the highway are not much better than 88 dBA. As our Truck Division has previously testified, they can be lowered to about 86 dBA in the reasonably near future, but anything significantly lower than that will require extensive engine development.

It is this line of reasoning that has led us to concentrate our

efforts over the last several years on reduction of noise at the operator's station. Of course, much of our work has resulted in improvements in ESL, even though that wasn't our primary purpose. The literature indicates that our industry in the last few years has doubled the power available to the farmer from his tractor while keeping the noise level the same. Benefits to the environmental sound level of the increased power include having fewer tractors running to do the work, and finishing it sooner. Other agricultural engineering contributions to lessened environmental noise include improved machines and farming practices resulting in fewer trips through the field to raise a crop.

International Harvester farm equipment engineers have been concerned with sound and have been making sound measurements for at least 20 years. We and our suppliers are continuing to work toward quieter machines without requiring our customers to use less effective mechanical products, with attendant cost increases for the farm products of food and fiber.

One sound control job we have done illustrates the biggest problem in quieting complex machinery: namely that with multiple noise sources, you must quiet them all to get much improvement. Figure 12 summarizes the program. We designed a tractor with a rather quiet fan and engine, but a noisy transmission, as shown by the dotted lines. This was a new type of transmission, and it had many attractive features, and greatly improved the productivity of the farmer. So we set out to make it quieter, and we did a pretty good job, as shown by the solid lines. We reduced transmission noise by 3 dBA. But we only quieted the tractor by 1 dBA.

We have considered the possibility of reducing sound levels by soft mounting the engine and transmission. The amount of reduction at 50 feet

appears to give only marginal improvement. Tractor design has grown from the need to keep a compact, narrow vehicle to provide versatility for mounting implements, good visibility, and row crop considerations. Thus the engine and transmission have become the integral structure for the vehicle. Strength considerations make for heavy housings that in turn tend to suppress sound amplification. It would appear that little improvement would be obtained by soft mounting the power train unit.

Going to a separate frame concept for all our tractors would mean starting in the engineering department with a clean piece of paper. For our industry, this would mean millions of dollars in engineering expense, and perhaps hundreds of millions for new manufacturing facilities. All this money must eventually come from the price we pay for food and clothing, with a doubtful improvement in ambient noise.

Agricultural machines are used only a few hours per year, about 600 hours average for a tractor. They are not usually concentrated in one area, and there are generally few people nearby. Environmental sound levels are generally well below the danger point for hearing loss, and their intermittent and infrequent nature minimize their environmental impact. Nevertheless, should regulation of environmental noise from agricultural machinery be deemed necessary, I would like to make two recommendations. First, the operator should have to meet no lower limit than the manufacturer had to meet when the equipment was made. In general, there is no way to retrofit to make older tractors more quiet, with the rare exception of a tractor originally built without an exhaust muffler. This is already apparent to us from our sound control work at International Harvester. Although these older tractors will be around a long time, they will be used less every year, reducing their contribution to environmental

noise.

Secondly, for maximum benefit at minimum cost, federal regulations must be preemptive, to preclude a proliferation of local rules.

I would like to close by identifying three sources of sound level data the panel might like to review. The Society of Automotive Engineers, with the financial support of the U.S. Department of Transportation, the Construction Industry Manufacturers Association, the Farm and Industrial Equipment Institute, and the Power Saw Manufacturers Association, issued a contract to Southwest Research Institute for a study of noise induced hearing damage risk for operators of farm and construction equipment. The report on this study is available from SAE as publication R-4. It will give you an idea of noise control work done by the industry so far, and will also give insight to the nature of the noise environment. I have a copy of this publication which I will leave with you.

Secondly, the University of Nebraska, at their Tractor Testing Laboratory, has been making sound level readings on all tractors tested beginning in 1970. These readings are available from the University of Nebraska, Department of Agricultural Engineering, Lincoln, Nebraska, 68503. The environmental sound level is taken at 7.5 meters, but if 4 or 5 dBA is subtracted from the published figures, the result should approximate the 50 ft. ESL. A summary of the 1970 test results was published on page 15 of the April 7, 1971 issue of Implement & Tractor, and I have appended a copy of this summary to my text. The 1971 tests are not yet complete.

The other source of information on tractor noise levels is the Organization for Economic Cooperation and Development. Environmental

sound level at 7.5 meters is included in their tractor test reports.

These are available in this country from:

OECD Publications Center
Suite 1305
1750 Pennsylvania Ave., N.W.
Washington, D. C. 20006

The parent organization is:

Organization de cooperation et de
Development Economiques
Chateau de la Muette
2 Rue Andre Pascal
Paris 16E, France.



FIGURE 1



FIGURE 2



FIGURE 3



FIGURE 4



FIGURE 5

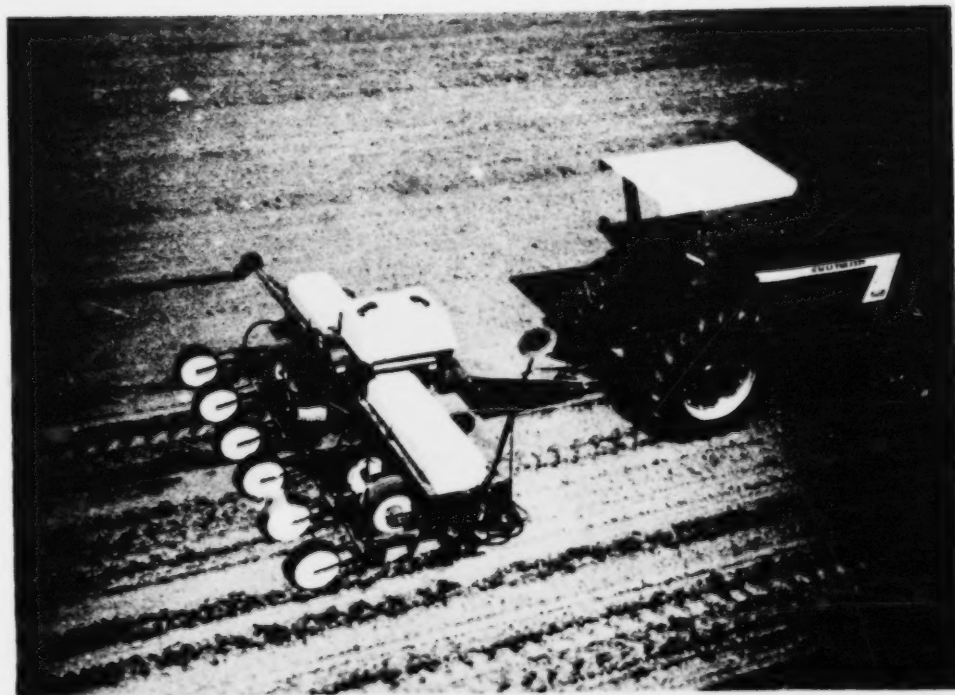


FIGURE 6



FIGURE 7



FIGURE 8



FIGURE 9

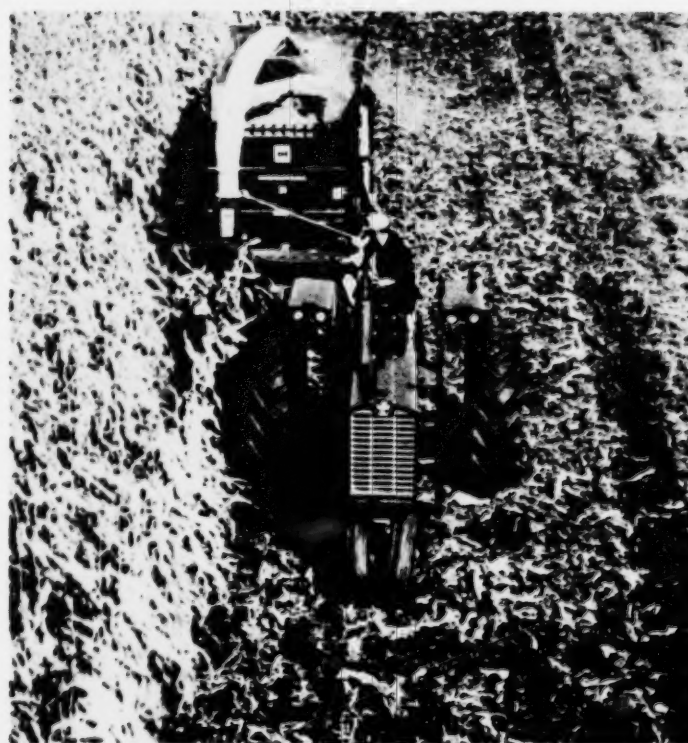


FIGURE 10



FIGURE 11

NOISE CONTROL RESULTS

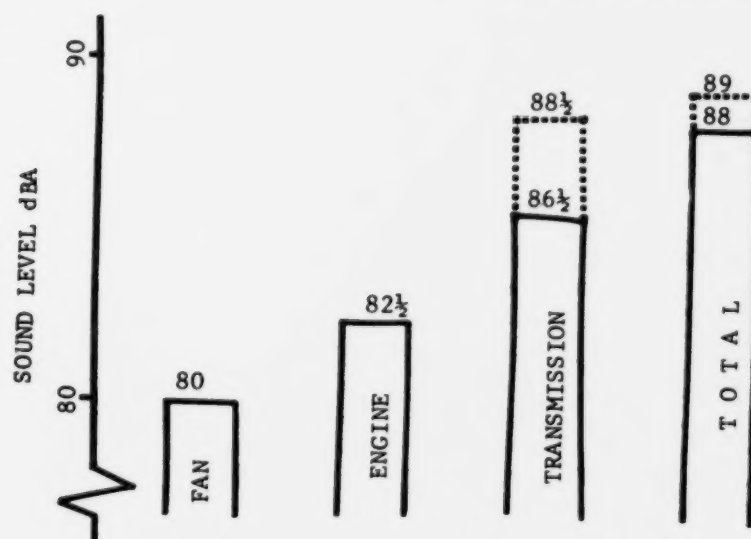


FIGURE 12

SOUND DATA FROM NEBRASKA TESTS

1970 Nebr. Test No.	Tractor Make & Model	PTO HP @ rated engine speed	Sound Level at 25 ft. dBA	Sound Level at Operator's Ear								Part throttle	
				Full throttle operation								50% load	
				100% load		75% load		50% load		50% load		50% load	
				dBA	sones	dBA	sones	dBA	sones	dBA	sones	dBA	sones
1054	Ford 2000 gas. 6-speed	30.58	81.3	98.5	142.5	96.5	121.5	93.5	98.5	93.5	98.5	94.5	103.0
1053	Ford 2000 dsl. 6-speed	31.97	86.9	100.0	157.3	98.5	136.0	96.5	123.0	96.5	123.0	94.5	103.0
1051	Ford 3000 gas. 6-speed	38.33	81.5	100.0	156.5	99.0	140.0	96.0	121.5	96.0	121.5	93.5	96.5
1052	Ford 3000 dsl. 6-speed	40.63	84.8	99.5	158.0	97.5	132.5	96.0	119.0	96.0	119.0	93.5	96.5
1061	Case 770 gasoline manual	56.32	83.5	89.5	84.0	89.0	77.5	88.5	69.0	88.5	69.0	89.5	69.5
1058	Case 770 dsl. power shift	56.77	88.4	93.5	87.0	94.0	88.0	94.0	84.5	94.0	84.5	89.5	69.5
1043	Allis Chalmers 175 dsl.	62.47	86.0	93.0	82.5	93.0	83.5	92.0	81.5	92.0	81.5	94.0	86.0
1042	Oliver 1655 gasoline	70.27	85.0	97.0	131.5	96.0	125.0	95.5	111.5	95.5	111.5	94.0	86.0
1041	Oliver 1655 diesel	70.57	88.0	98.5	143.5	99.0	134.0	97.0	120.0	97.0	120.0	94.0	86.0
1059	Case 870 gas. power shift	70.65	84.4	92.5	98.5	90.5	87.5	89.0	78.0	89.0	78.0	88.0	75.5
1060	Case 870 gas. manual	71.06	84.4	91.5	95.0	90.0	89.0	88.5	77.5	88.5	77.5	87.0	69.0
1044	Allis Chalmers 185 dsl.	74.87	88.5	94.5	98.0	96.0	105.5	94.5	99.0	94.5	99.0	90.5	72.5
1046	IHC 826 hydro. dsl. w/cab	84.66	89.0	99.5	131.0	98.0	122.0	95.5	100.0	95.5	100.0	94.0	86.0
1039	Case 970 gas. manual	85.02	86.0	92.0	105.5	92.0	104.5	90.5	92.0	90.5	92.0	94.0	86.0
1038	Case 970 gas. power shift	85.23	85.5	91.5	94.0	91.5	90.0	89.5	78.0	89.5	78.0	93.5	87.0
1037	Case 970 dsl. power shift	85.31	89.5	93.0	89.0	95.0	96.0	95.5	95.0	95.5	95.0	91.0	80.5
1034	Case 970 dsl. manual	85.70	90.0	94.0	92.0	94.5	77.5	94.5	86.0	94.5	86.0	92.5	80.5
1057	Oliver 1755 diesel	86.93	92.5	97.5	110.0	96.5	111.5	96.0	110.5	96.0	110.5	92.5	80.5
1056	Oliver 1755 gasoline	86.98	86.0	94.0	92.0	94.0	100.0	94.0	99.5	94.0	99.5	91.5	100.5
1045	IHC 826 diesel w/cab	92.19	88.0	95.0	104.5	96.0	107.5	97.0	103.0	97.0	103.0	90.0	71.5
1040	Oliver 1855 diesel	98.60	86.5	93.5	97.0	95.0	102.0	94.0	93.5	94.0	93.5	94.5	86.0
1036	Case 1070 dsl. power shift	100.21	89.5	95.0	96.5	94.0	93.0	96.0	94.5	96.0	94.5	91.0	77.5
1035	Case 1070 dsl. manual	100.73	89.5	95.0	93.0	94.5	85.5	95.5	90.0	95.5	90.0	91.0	77.5
1055	Oliver 1955 diesel	108.16	87.3	95.5	109.0	95.5	106.5	95.5	103.0	95.5	103.0	95.3	80.5
1047	IHC 1026 hydro. dsl. w/cab	112.45	88.0	97.5	110.0	95.5	103.5	93.5	121.5	93.5	121.5	90.0	79.0
1050	John Deere 4320 dsl. w/cab	116.55	88.4	92.0	81.0	92.5	82.5	92.5	80.0	92.5	80.0	89.0	65.5
1062	Case 1170 diesel w/cab	121.93	89.0	89.5	75.5	91.0	79.5	90.0	74.5	90.0	74.5	93.0	76.5
1048	IHC 1456 diesel w/cab	131.80	86.4	93.0	84.0	92.0	82.5	91.5	79.0	91.5	79.0	99.0	118.0
1049	Massey Ferguson MF 1150 dsl.	135.60	91.4	99.0	125.0	98.5	118.5	98.5	118.0	98.5	118.0	99.0	118.0